Practical Management of Lisfranc injuries in Athletes

Christian Lattermann, MD§; Jordan L Goldstein, MD†; Dane K. Wukich#; Simon Lee, MD* and Bernard R. Bach Jr., MD1*

*Department of Orthopedic Surgery
Rush University Medical Center
1725 W. Harrison Street, Suite 1063;
Chicago IL 60612

1) Director of Sports Medicine

§ Fellow, Sports Medicine

† Resident (PGY-3)

# Chief of Foot and Ankle Surgery
Department of Orthopaedic Surgery
University of Pittsburgh Medical Center
1010 Kaufmann Bldg, 3471 Fifth Avenue
Pittsburgh PA 15213

ADDRESS FOR REPRINTS/CORRESPONDENCE:

Bernard R. Bach, Jr., M.D.
Division of Sports Medicine
Rush University Medical Center
1725 W. Harrison St., Suite 1063
Chicago, IL  60612
e-mail:  brbachmd@comcast.net
Phone:  312-432-2321
Fax:  312-942-1517

Running Title:  Practical Management of Lisfranc Injuries
Abstract:

Foot injuries are common in athletes. Injuries to the midfoot and particularly the Lisfranc joint are less common but have a high risk of ending the athletes’ season or even career. Lisfranc injuries can be difficult to diagnose and often lead to a disastrous outcome when missed. Team physicians and primary care physicians who see athletic injuries should be vigilant in order not to miss these injuries. Familiarity with the subtle clinical signs of a Lisfranc injury and knowledge of the basic treatment algorithm will help the clinician to better treat these injuries successfully.
**Introduction:**

Foot and ankle injuries are among the most common injuries in athletes. Approximately 25% of all sports related injuries are to the foot and ankle. Garrick and Requa showed that 16% of all sports related injuries involve the foot (1). Although less frequent than other athletic injuries, midfoot sprains or “Lisfranc” joint injuries can be career ending injuries and therefore need to be taken very seriously by the athlete, the trainers, and physicians.

The on field diagnosis of Lisfranc injuries is difficult. The athlete usually reports a mechanism of injury similar to an ankle sprain and will often attempt to “walk it off”. It is not uncommon that the athletic trainer or team physician is not initially involved in the care of this type of injury because the athlete underestimates the severity of the injury and attempts to let the injury resolve with time.

The goal of this review is to educate athletic trainers, team physicians, and primary care physicians who see athletes to better recognize and evaluate for Lisfranc joint injuries.

**Injury mechanism:**

Mechanisms leading to a Lisfranc injury can roughly be divided into high and low energy injuries. High velocity Lisfranc injuries are commonly seen in high speed motor vehicle accidents. The foot is usually planted on the brake pedal or the floor of the motor vehicle in order to break the forward motion after impact. Most commonly the foot gets forced into hyper plantar flexion with either a valgus or varus component. The energy leading to these injuries usually disrupts the osteo-ligamentous restraints and leads to a dislocation of the Lisfranc joint. This results in gross instability and often causes neurovascular
damage. These injuries have a high risk for compartment syndrome due to soft tissue swelling and disruption of the dorsalis pedis artery. While these injuries are commonly seen in the trauma bay of level one and level two trauma centers, they present distinctly differently from the more subtle instability injuries of the Lisfranc joint that occur in athletes after low velocity injuries.

Low velocity injuries to the Lisfranc joint typical follow one of two mechanisms. The first is forced hyperplantarflexion of the midfoot that occurs in athletes utilizing foot straps such as surfers, windsurfers, and equestrians. Typically the foot gets trapped in the foot strap and the body falls straight backwards leading to the hyperplantarflexion of the foot. This mechanism is in fact the classic mechanism of Lisfranc injuries as described by Jaques Lisfranc after observing cavalry men fall off their horse with their foot trapped in the foot strap dragging the rider alongside the horse resulting in a slow hyper plantar flexion of the foot.

A second mechanism has been described by Shapiro who had looked at football players, particularly linemen (2). He noticed a typical mechanism of injury occurring with the lineman’s stance during a block with the foot plantar flexed and the metatarso-phalangeal joints maximally dorsiflexed while a force is directed directly down onto the heel (i.e. by a falling player, tackle from behind) which leads to a hyperplantarflexion in the Lisfranc joint and subsequent injury. Several other sports specific mechanism that are variations of the above described mechanisms have been reported such as sliding into fixed bases (baseball) or landing on a fully plantarflexed foot (parachuting).
**Diagnosis:**

Whereas these injuries can clinically be easily identified in high velocity type mechanisms due to excessive swelling, ecchymosis, severe pain and midfoot instability, the low velocity type injuries may be very subtle and hard to detect. It is imperative that any athlete who complains about a sprained ankle or foot needs to be thoroughly examined. Distracting injuries such as ankle injuries or fractures may cause the examiner to miss the often more subtle midfoot injuries. The foot must be palpated. Of particular importance are bony landmarks such as the navicular, medial cuneiform, base of the first and fifth metatarsal as well as the space between first and second metatarsal. Any point tenderness in any of these areas is a sign of injury to the midfoot and a Lisfranc injury should be considered. This often times may be difficult due to acute swelling, and as a result may need repeat examination after the swelling improves. Furthermore, the stability of the Lisfranc row can be assessed by passive pro- and supination of the forefoot. Significant pain with this maneuver at the base of the first metatarsal is suspicious for a Lisfranc injury. Another way to test this is to perform a passive dorsiflexion and abduction of the forefoot. This puts strain on the medial column and serves as an “apprehension” sign if positive. Another delayed clinical sign is a subtle ecchymosis on the plantar aspect of the midfoot. Apart from these subtle signs there may also be gross instability, crepitus or deformity present- even in low velocity type injuries. It is imperative, particularly for the initial evaluation, that both feet are examined since both feet could be involved in the mechanism (windsurfing, parachuting). In addition a full neurovascular exam should be performed of the foot since these injuries can lead to neurovascular injuries which further complicate the outcome and prognosis.
Imaging:

Standard imaging of the foot should always be done with a minimum of three views of the foot. This includes an “A/P”, “30 degree oblique” and “lateral” of the foot, weight bearing if tolerated will help to accentuate the deformities. These standard views need to be evaluated for several radiographic tell tale signs. Any fracture of the base of the first three metatarsals is very suspicious for an injury at the Lisfranc joint. Small avulsions at the medial base of the first or second metatarsal suggest disruption of the tarso-metatarsal ligaments (base of first) or the Lisfranc ligament (base of second). In addition to a thorough screening for fresh fractures or avulsions, indirect signs of a Lisfranc-instability should be looked for. The medial cortex of the second metatarsal should line up perfectly with the medial border of the 2nd cuneiform on an “A/P” x-ray of the foot. *Any displacement of more than 2 mm between the base of the first and second metatarsal in an “A/P” radiograph of the foot should raise suspicion of a Lisfranc injury.* Additionally, the medial cortex of the fourth metatarsal should line up perfectly with the medial border of the lateral cuneiform in the “30 degree oblique” x-ray of the foot (Fig 1). Finally, on the non-weight bearing lateral x-ray of the foot there should be no interruption of the dorsal cortical line of the first metatarsal to the medial cuneiform, any displacement is pathologic (Fig 2). Non-weight bearing x-rays of the foot may only raise the suspicion of the examiner and need to be correlated with the clinical findings. *If there is any significant tenderness at any of the bony landmarks and non-weight bearing films are negative it is imperative to obtain a “weight bearing A/P” and “weight bearing lateral”.* Weight bearing films will usually reveal subtle instabilities not seen on non-weight
bearing films. While it is not always practical to obtain weight bearing films of the foot in the initial ER setting, it remains imperative that weight bearing films are performed early on if there is a clinical suspicion with negative non-weight bearing films. The weight bearing film should be the gold standard if the x-rays are obtained in an office setting (Fig 3). If there remains any doubt, either stress views or an MRI can be obtained.

The primary utilization of MRI or CT may be helpful in special cases but is not necessary to make the diagnosis. For those patients that present several weeks or months after the injury, a bone scan provides valuable information when the Lisfranc joint shows increased uptake. Increased uptake particularly in the first and second tmt joint is highly suggestive of a Lisfranc injury.

Classification:
Several classification systems have been described for Lisfranc injuries (3, 4). While most of these classification systems are helpful for the radiographic description of high energy injuries with massive displacement they do not help in the diagnosis or outcome assessment of subtle Lisfranc instabilities as they occur in athletes. Nunley and Vertulla introduced a useful classification for subtle Lisfranc injuries with minimal or no displacement on weight bearing films (5). These injuries are the more likely scenario that a primary care physician or orthopaedic surgeon is going to encounter in an athlete. Nunley utilized three aspects of the patients’ exam and radiographic findings. He included the ability to weight bear, local point tenderness over the Lisfranc ligament, and medial first TMT joint space as well as the radiographic appearance of the Lisfranc joint. He established three different stages of Lisfranc instability. Patients with a stage one
injury were able to weight bear but could not return to play. On exam, they were locally point tender over the medial aspect of the first TMT joint but radiographically, did not show any diastasis of more than two mm between the first and second MT on the A/P weight bearing x-ray of the foot as well as no collapse of the arch as measured by the cuneiform-5th metatarsal vertical distance. It should be noted, however, that these patients may have a positive bone scan or MRI. Patients with stage two injuries had similar physical findings as patients in group 1 but showed a two to five mm diastasis between the first and second MT on the A/P weight bearing radiograph of the foot. Notably, there was no collapse of the arch in the weight bearing lateral radiograph. Patients with a stage three injury presented with an additional collapse of the longitudinal arch as documented in a lateral radiograph of the foot.

Initial Treatment:

The initial treatment of any foot injury is elevation and icing. Once the initial on-field treatment has been provided the patient needs to be thoroughly evaluated in an ER or office setting.

If the athlete is unable to ambulate without pain she / he needs to remain non-weight bearing until she / he has been evaluated and severe injuries to the foot and ankle have been excluded. Particularly after high energy trauma the foot can show massive swelling that should alert the treating physician or athletic trainer to a possible compartment syndrome. Diagnosis of a foot compartment syndrome is difficult and should be left to an expert. The usual clinical tell tale sign of a compartment syndrome: “pain with passive stretch”, is not accurate. Fullness of compartments is difficult to assess due to the
inaccessibility of the actual muscular compartments. If neurovascular symptoms are described, the compartment syndrome is already established. The evaluating physician should, therefore, be very suspicious if the patient complains of pain out of proportion to physical examination. Pressure measurements have been advocated. Controversy exists regarding pressure measurements in the foot since there is no reliable data concerning baseline pressures in foot compartments. Sequentially inflatable foot pumps used to decrease swelling should be avoided during the initial evaluation period in order to not increase compartment pressures.

**Non-operative treatment of Lisfranc injuries:**

Once the diagnosis has been established, the injury grade should be determined. A stage one Lisfranc injury that is functionally stable can be treated conservatively in a well molded non-weight bearing fiberglass cast for 6 weeks. If the patient is pain free to palpation at cast removal a custom molded orthosis should be worn and the patient can gradually return to his sports specific training. If the patient is still point tender then a custom molded weight bearing ankle foot orthosis should be worn for an additional 4 weeks (5). At this point it should be mentioned that any Nunley stage two or three Lisfranc sprain will lead to instability if treated conservatively and non-operative treatment is not recommended.

**Operative treatment of Lisfranc injuries:**

Patients with any displacement at the Lisfranc joint (stages 2 or higher) should undergo operative treatment. Intra-operatively, if the Lisfranc joint can be anatomically reduced
under fluoroscopy it may be amenable to a percutaneous placement of a screw. If a perfect reduction cannot be obtained an open reduction and internal fixation should be performed in order to restore the Lisfranc joint to a functional unit.

The Lisfranc joint can be reduced with a large tenaculum or a “towel clip” either percutaneously or open. Depending on the severity of the sub / dislocation of the Lisfranc joint, two or three screws can be utilized to stabilize the medial cuneiform against the base of the second metatarsal. If the injury also involves the 4th and 5th metatarsals then additional wires need to be placed through the base of the 4th and 5th metatarsal into the cuboid and middle cuneiform.

Postoperative treatment usually involves a non-weight bearing cast or boot for a minimum of 8 weeks. Between 8 and 12 weeks partial weight bearing is allowed. After 3 months the patient progresses to full weight bearing and should be placed in a custom molded orthosis. Hardware removal may be required in athletes. The recommendation is to remove the hardware at 12 – 16 weeks in athletes less than 200 pounds and after 24 weeks in athletes over 200 pounds. In non-athletes the screws may be left in place, additional wires in the 4th and 5th metatarsal need to be removed between 8and 12 weeks post-operatively (5).

Outcome of Lisfranc injuries in Athletes:

Literature on the outcome of Lisfranc injuries in athletes is sparse. Three original studies have been conducted in athletes. One study conducted by Meyer et al. (6) reported about 23 patients who were treated conservatively with good overall outcomes. In his series there were only three patients that radiographically had a diastasis of more than 2 mm
between the first and second metatarsal. Interestingly two of these three were initially not diagnosed. These three patients had a prolonged recovery with one of the three continuing to have significant midfoot pain with activity. Shapiro reported about a series of nine athletes with a diastasis between 3 and 5 mm who were treated conservatively (2). The one athlete who had a diastasis of 5 mm was treated operatively and did very well, while the other 8 with a diastasis of 3 mm were treated conservatively with excellent outcome. Nunley, however, reported on about 15 patients, out of which two with even minimal diastasis of 3 mm did not do well with conservative management (5). Curtis et al. (7) and Davis et al (8) also report failures and inferior results of non-operative management in athletes with minimal Lisfranc instability. The consequence of missed diagnosis can lead to early arthritis, secondary deformity, arch flattening and chronic pain (4,7,8).

**Conclusion:**

Lisfranc injuries are uncommon injuries in athletes that can, however, have grave consequences for the athletes’ career. A true midfoot sprain involving the Lisfranc joint presenting without any sign of instability in weight bearing x-rays should be regarded as a sprain and should be treated conservatively as outlined above (Table 1). Any instability detected in weight bearing films should be considered for surgical reduction and stabilization in order to avoid prolonged unsuccessful attempts of conservative treatment and long term sequelae. The athlete should also be informed that this injury will sideline them a minimum of 12 to 16 weeks with conservative or operative treatment. Finally it should be stressed that any diagnosis of a Lisfranc sprain that is treated conservatively
has to be scrutinized with weight bearing x-rays in order to rule out any subtle instability (Table 1).

References:

Figure Legend:

Figure 1:

A/P and oblique non-weight bearing x-ray. The latter A marks the two tangential lines on the first MCP joint. The letter B marks the 2\textsuperscript{nd} metatarsal cortical line meeting the medial cortex of the middle cuneiform. The circle marks the keystone that is built by the 2\textsuperscript{nd} metatarsal head as it articulates with the medial and middle cuneiform. The letter C delineates the tangential along the 4\textsuperscript{th} metatarsal on the oblique radiograph of the foot.
Figure 2:

Lateral non-weight bearing radiograph of a right foot. The two lines are the tangentials that define the alignment of the first MCP joint. Any step off along this tangential signifies an instability in the first MCP.
Fig 3:

Subtle sign of a Lisfranc injury. The left image is a non-weight bearing x-ray showing a minimal displacement (A) that can easily be missed. The right film is a weight bearing film showing a wide gap (B).
Table 1:
Flow Chart for the Management of Lisfranc Injuries in Athletes

- **Injury**
  - **Initial Evaluation**
    - *No tenderness in toe/foot*
    - *No significant swelling*
    - *Able to ambulate* 
  - *Check ankle joints*
  - *Check for swelling*
  - *Try walking it off*
  - *Tenderness over 1st MCP joint*
  - *Painful swelling loculated*
  - *Unable to ambulate*
  - *Can not walk it off*
  - *Still problems at end of game*

- **X-rays**
  - **Radiographic instability**
    - Lisfranc injury with instability
    - Operative treatment
  - **No radiographic instability**
    - Bone Scan
      - Continued symptoms after non-operative treatment
        - Lisfranc sprain
        - Non-operative treatment